Appendix A

Spatial Modeling of Landscape Potential for the Vegetation Treatment Program (VTP) – Executive Summary
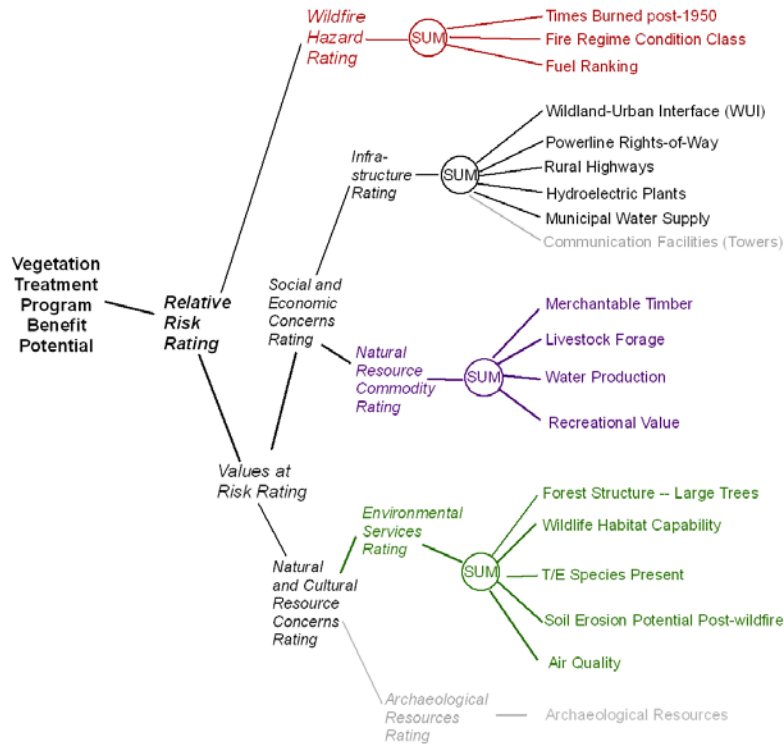
Abstract

The proposed Vegetation Treatment Program (VTP) of the California Department of Forestry and Fire Protection (CAL FIRE) will operate on a base of approximately 37 million acres of wildland vegetation throughout California. About 90% of the base area is on private, non-federal jurisdiction lands, where land use varies from wildland-urban interface (WUI) zones, to commercial timber production, to sparsely populated ranches or non-commercial private lands.

Not all eligible wildland acres are in equal need of, or would equally benefit from, vegetation treatment under the program. Areas where there are commercial and noncommercial assets at risk, and those with a buildup of hazardous fuels can benefit greatly from treatment, whereas more remote areas of less value may not be of primary importance for receiving treatment. And in some areas particular treatment practices, such as mechanical removal of vegetation, may be limited or excluded for environmental or other reasons.

In support of the PEIR, we performed two Geographic Information System (GIS) based analyses to map areas eligible for VTP projects, to highlight those watersheds: 1) of greater potential program need of (and benefit from) vegetation and fuels treatments (the "benefit potential" or allocation model); and 2) where certain treatment practices (e.g. prescribed burning) may be constrained due to other considerations in the landscape (the "constraints model"). Potential treatment need was based on the relative concentrations of both natural and development-related assets in the watershed that would benefit from the program (e.g. structures, timber, water quality, etc.). Potential treatment constraints were mapped with respect to the five main practices (prescribed burning, mechanical treatment, manual treatment, herbicide treatment and herbivory (i.e. domestic animal grazing)) of the program. Available spatial data from various sources (mostly CAL FIRE) was synthesized into watershed-based evaluations of wildfire hazard, landscape values at risk (social, economic, natural, and cultural resources) and potential constraints using logic developed by CAL FIRE staff. Figure A.1 shows graphically the process of how each of the above maps was derived. Reading the graphic from left to right shows the specific data and evaluations that were used to create the final maps. The resultant maps provide a view as to how the program could allocate and help prioritize program vegetation treatment projects, according to their relative need and potential benefit.

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Vegetation Treatment Program GIS Benefit Potential Model

last update 04/11/2007

Figure A.1 Graphic showing the basic logic and generic data inputs used for the landscape-based Relative Risk Rating assessment

VTP Spatial Domain

The VTP area of operation includes lands that are under CAL FIRE jurisdiction and have wildland vegetation cover. Using Calwater Planning Watershed Units (PWS), Figure A.2 shows the percentage of each PWS under CAL FIRE (and VTP) jurisdiction, including direct protection areas CAL FIRE provides to lands under federal jurisdiction. This analysis was performed at the planning watershed level of aggregation. Maps rendered for this analysis show only those areas of each PWS under CAL FIRE (and VTP) jurisdiction, with non-jurisdictional areas colored gray.
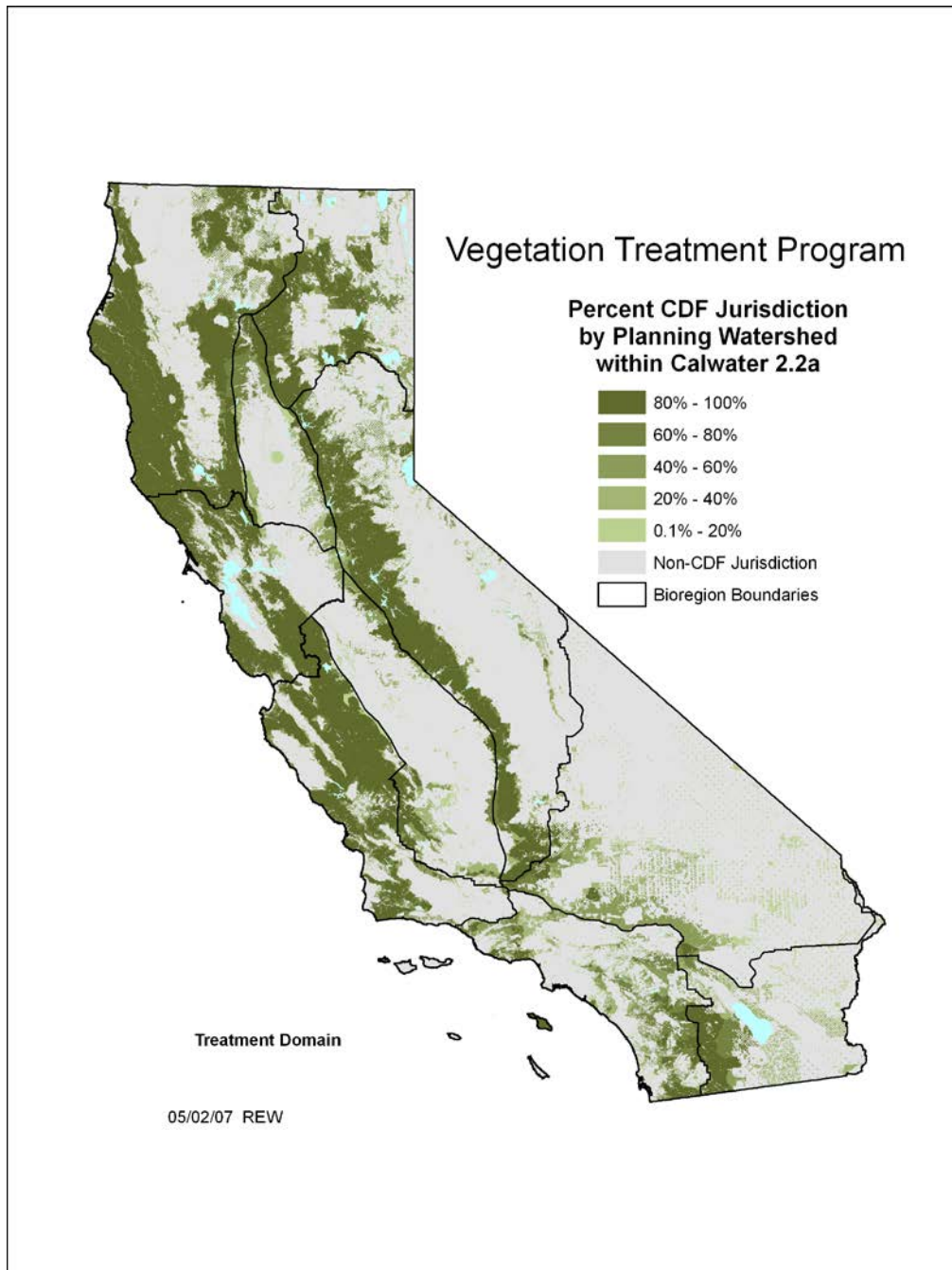
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Figure A.2 The percentage of Calwater planning watershed (PWS) units of VTP jurisdiction

Appendix A

Table A.1	
Main Areas (by Bioregion) of VTP Operation	
Bioregion	**VTP main areas of operation**
Klamath / North Coast	1) North Coast Mountains and valleys, 2) Klamath Mountains and valleys in Shasta / Siskiyou counties
Modoc	3) Southern (west side of) Cascades, 4) Northeastern Plateaus
Sacramento Valley	5) Northern end of valley in Shasta and Tehama counties, 6) Fringe of Sierra foothills
Sierra Nevada	7) Foothills and middle elevations on west side 8) Arid mountains near Tehachapi
Bay Area / Delta	9) North of San Pablo Bay: non-agricultural hills and mountains 10) East and SE of Bay: non-developed, non-agricultural hills and mountains 11) Coast ranges west of Santa Clara Valley and development
San Joaquin Valley	12) Very fringe of Sierra foothills 13) southwest corner in the coastal dry plains
Central Coast	14) Hills and mountains (Gabilan and Diablo Ranges) east of Salinas Valley 15) Coast ranges (Santa Lucia Range) west of Salinas Valley and hills and valleys west of Transverse Range
Mojave	16) (Very little of bioregion) Western fringe, bordering the Sierra Nevada and South Coast bioregions
South Coast	17) Undeveloped hills of Ventura county 18) Isolated rugged lower-elevation mountains (e.g. Santa Ana Mountains)
Colorado Desert	19) Anza Borrego State Park 20) Laguna Mountains area west of park and east of San Diego

VTP Benefit Potential

 VTP The final result of the landscape benefit potential modeling exercise is the Relative Risk map (Figure A.3). It ranks Calwater planning watersheds benefit potential into highest, high and moderate by two landscape criteria: 1) the level of hazard from wildfire; and 2) the concentration of values or assets. Watersheds with the highest ranking (brown) are high in both criteria, whereas those with high or moderate have a lesser ranking in one or both.
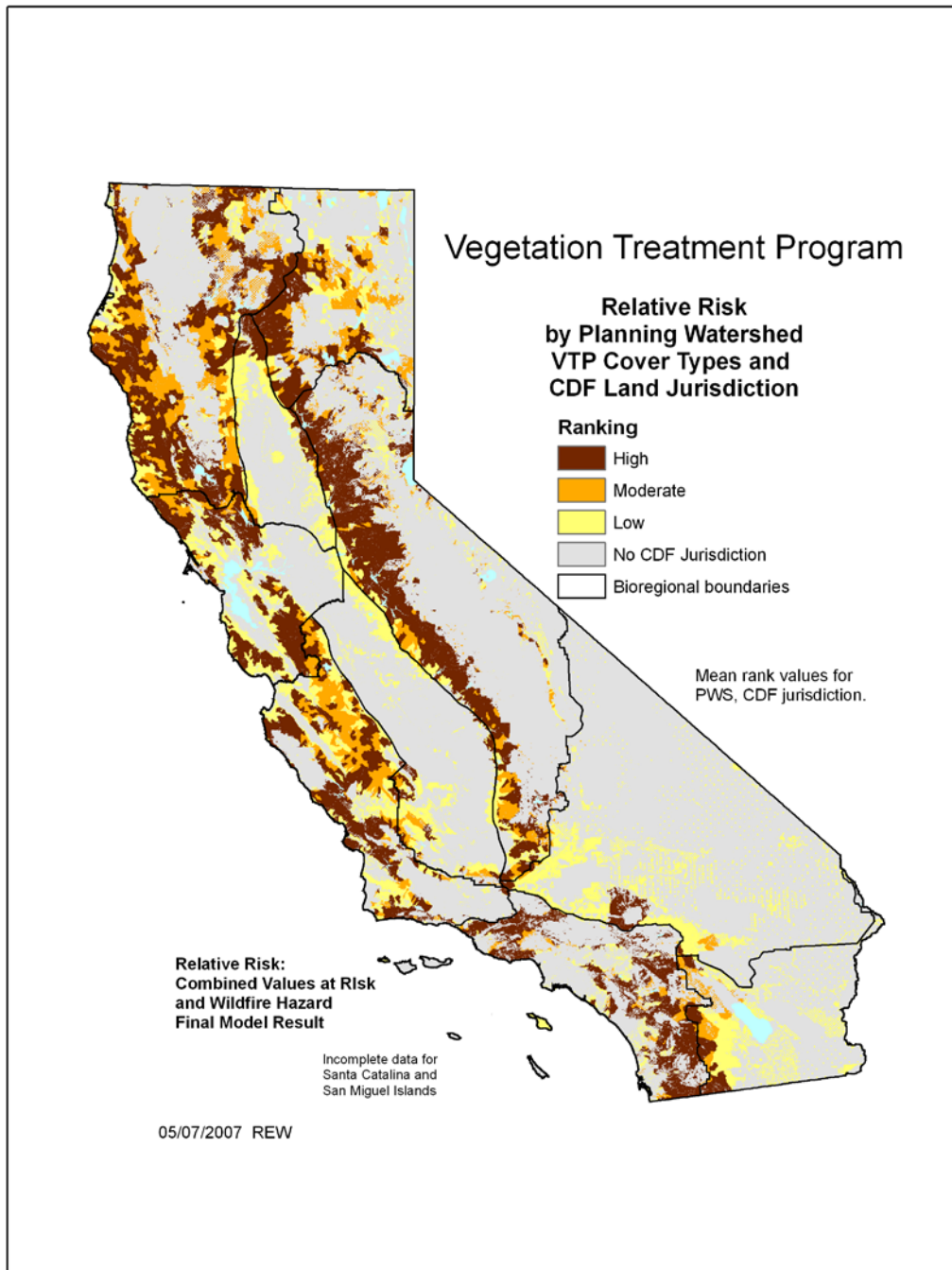
Figure A.3 Relative Risk is the final result map of the benefit potential / opportunity GIS model, combining wildfire hazard level and concentration of values at risk by Calwater planning watershed.

The highest ranking areas shown in map of Relative Risk are where there is a co-occurrence of wildland vegetation and infrastructure (buildings, powerlines, etc.), although natural resources at risk also play a significant role. By bioregion (CBC 2000), watersheds of highest rank of potential benefit are most prevalent in scattered areas of the Klamath / North Coast bioregion; concentrated in the western foothills and lower elevations of the Cascade mountains

in the Modoc bioregion; throughout the western foothills and middle elevations of the Sierra Nevada Bioregion; less-developed forested and brush-covered hill and mountain areas of the Bay Area / Delta Bioregion; coastal forests in the Central Coast Bioregion; and scattered undeveloped areas of mostly chaparral in the South Coast Bioregion.. The desert Bioregions (Mojave, Colorado Desert) have a few small areas bordering the bioregions to their east.

The two source maps for the Relative Risk map are shown in Figures A.4 and A.5, the Wildfire Hazard Rating map and the Values at Risk map. The map of Wildfire Hazard Rating (Figure A.4) was produced by merging data from three CAL FIRE sources: Number of Times Burned since 1950 (FigureA.6a); Fire Regime Condition Class (Figure A.6b); and Fuel Ranking (Figure A.6c). Areas of high risk of wildfire tend to be where it has frequently burned in recent decades, where the vegetation type is adapted to frequent burns, and where there is a buildup of fuels.

The map of Values at Risk was produced by synthesizing a large amount of data on the concentrations of infrastructure, natural resource commodities and non-commercial environmental services. The two maps used to create the Values at Risk were the Social/Economic Concerns (Figure A.7) and the Natural/Cultural Resource Concerns (Figure A.8). The Social/Economic Concerns map was in turn derived from evaluations of data on Infrastructure and Natural Resource Commodities (Figures A.9a and A.9b). The Natural/Cultural Resource Concerns map was made from an evaluation of Environmental Services provided by the landscape (Figure A.10).

Maps of input data (lowest model level)

The root level of the analysis began with the data used as inputs for synthesis and evaluation. The data for the simple Wildfire Hazard are described above. Here we elaborate on the data used in the main model evaluations: Infrastructure, Natural Resource Commodities (used for Socio/Economic Values of Concern) and Environmental Services (used for Natural/Cultural Resource Values of Concern).

The Infrastructure Values map (Figure A.9a) was determined by five data sources: 1) Wildland-Urban Interface; 2) Power Line Rights of Way; 3) Rural Highways; 4) Municipal Water Supplies; and 5) Hydroelectric Plants, shown in Figures A.11a through A.11d. Assets for each data source were ranked 1 (lowest) to 3 (highest), similar to the system used for FirePlan data. All input data to Infrastructure were weighted equally.

The Natural Resource Commodities Values map (Figure 9b) was determined by three data sources (and an evaluation): 1) Merchantable Timber; 2) Livestock Forage; and 3) Water Production; and an evaluation of Recreational Values (Figures A.12a through A.12d). Recreational Values were derived taken three primary data sources: 1 kilometer areas surrounding lakes larger than 100 ha (250 acres) in size; scenic visibility, and accessibility to the public.

The Environmental Services Values map (Figure A.10) used five data sources: 1) Forest Structure (large trees) Assets; 2) Soil Erosion Potential: 3) Air Quality (based on PM-10 non-attainment); 4) Total Wildlife Habitat Capability and 5) Presence of Sensitive Species (Figures A.13a through A.13e).
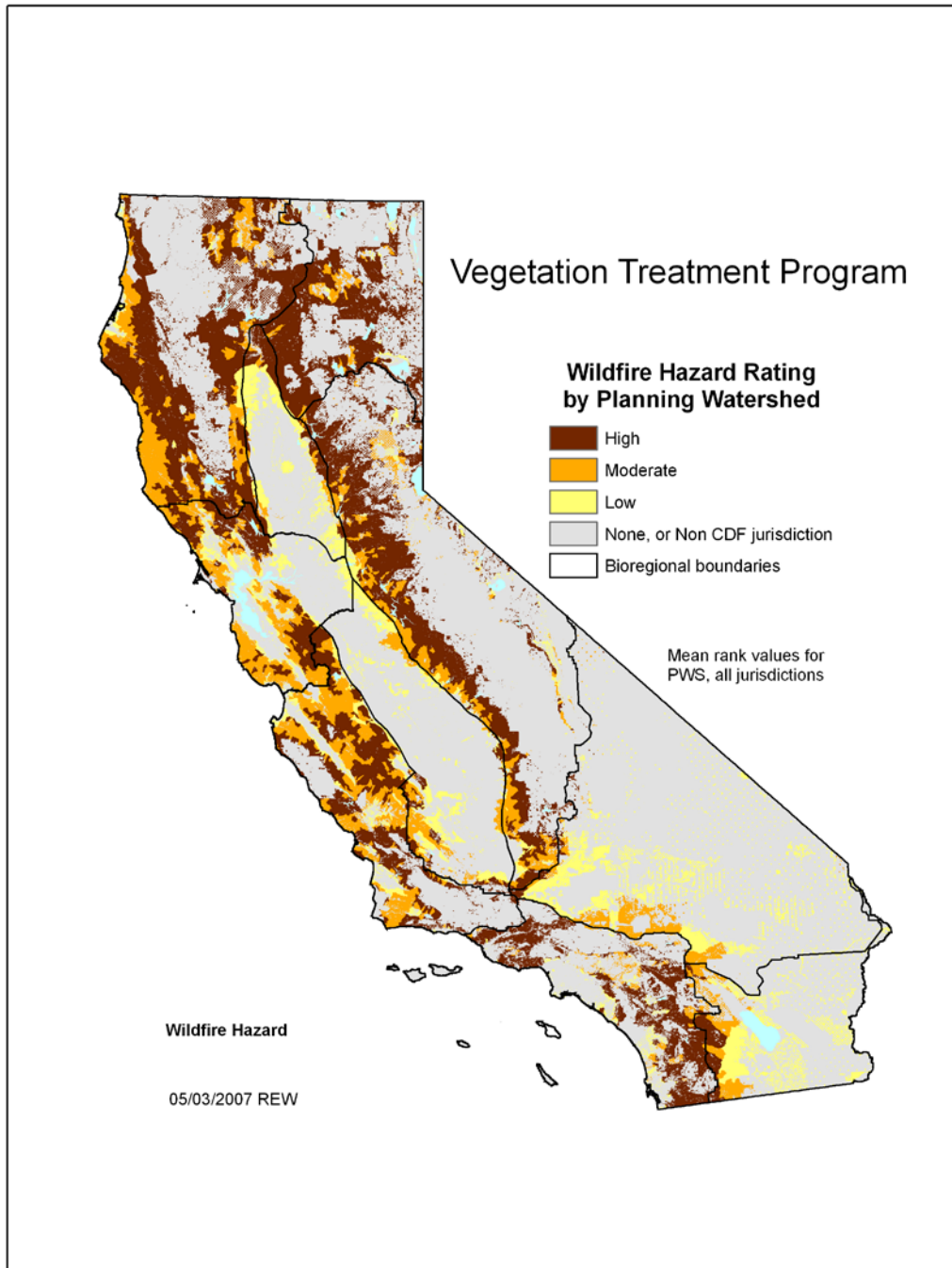
Figure A.4 The Wildfire Hazard Rating map combines three maps by Calwater Planning Watershed: the Number of Times Burned since 1950, Fire Regime Condition Class and Fuel Ranking. This is the first of the two inputs to the final Relative Risk map.
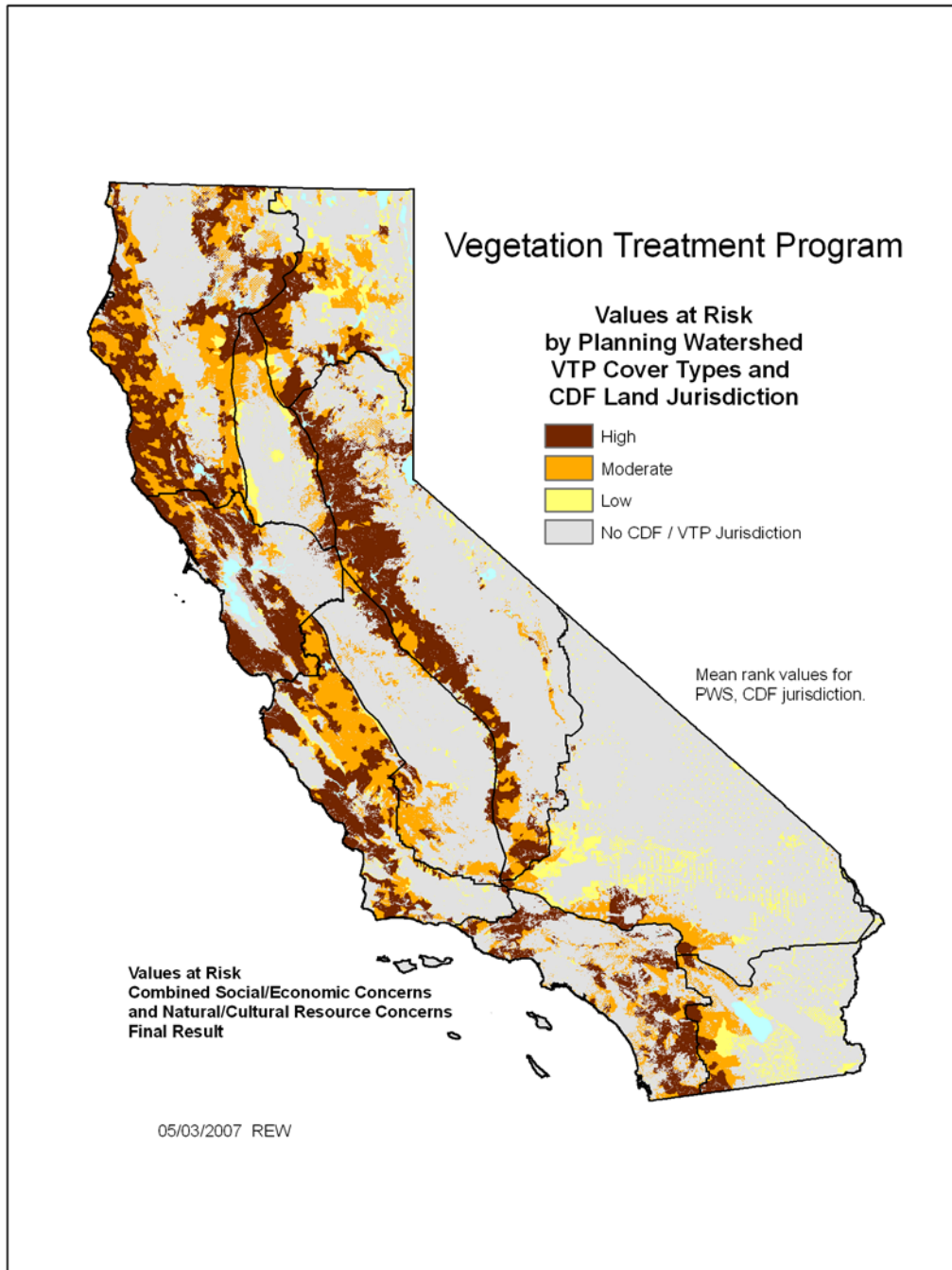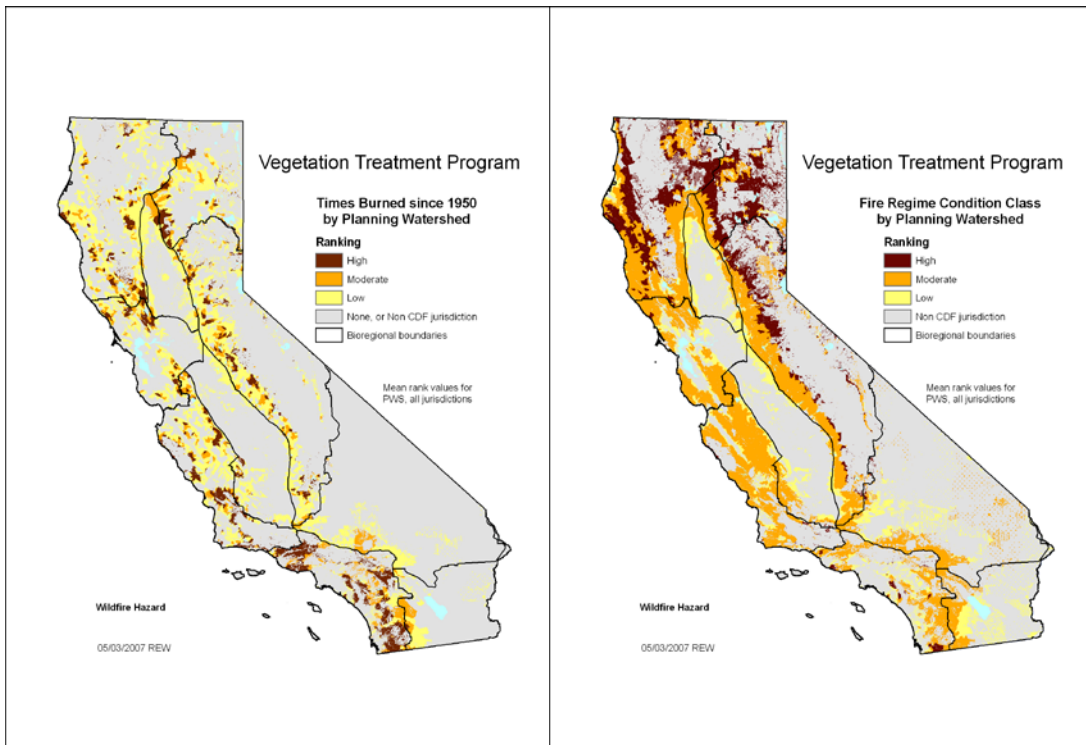
Figure A.5 The Values at Risk map combines two maps by Calwater Planning Watershed: the Social/Economic Concerns and the Natural/Cultural Resource Concerns. This is the second of the two inputs to the final Relative Risk map.

Figures A.6a and A.6b Rankings of the first two of three inputs to Wildfire Hazard Rating: Times Burned since 1950, and Fire Regime Condition Class.
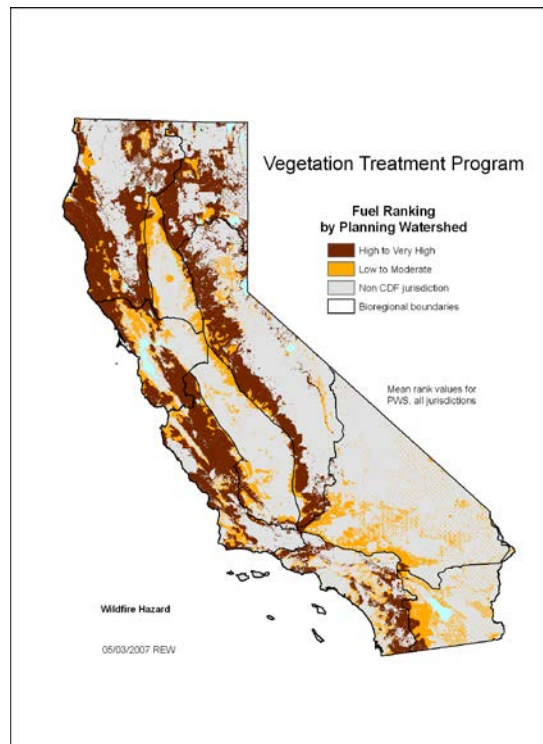

Figure A.6c The third of three inputs to the Wildfire Hazard Rating: Fuel Ranking. All inputs were weighted equally.

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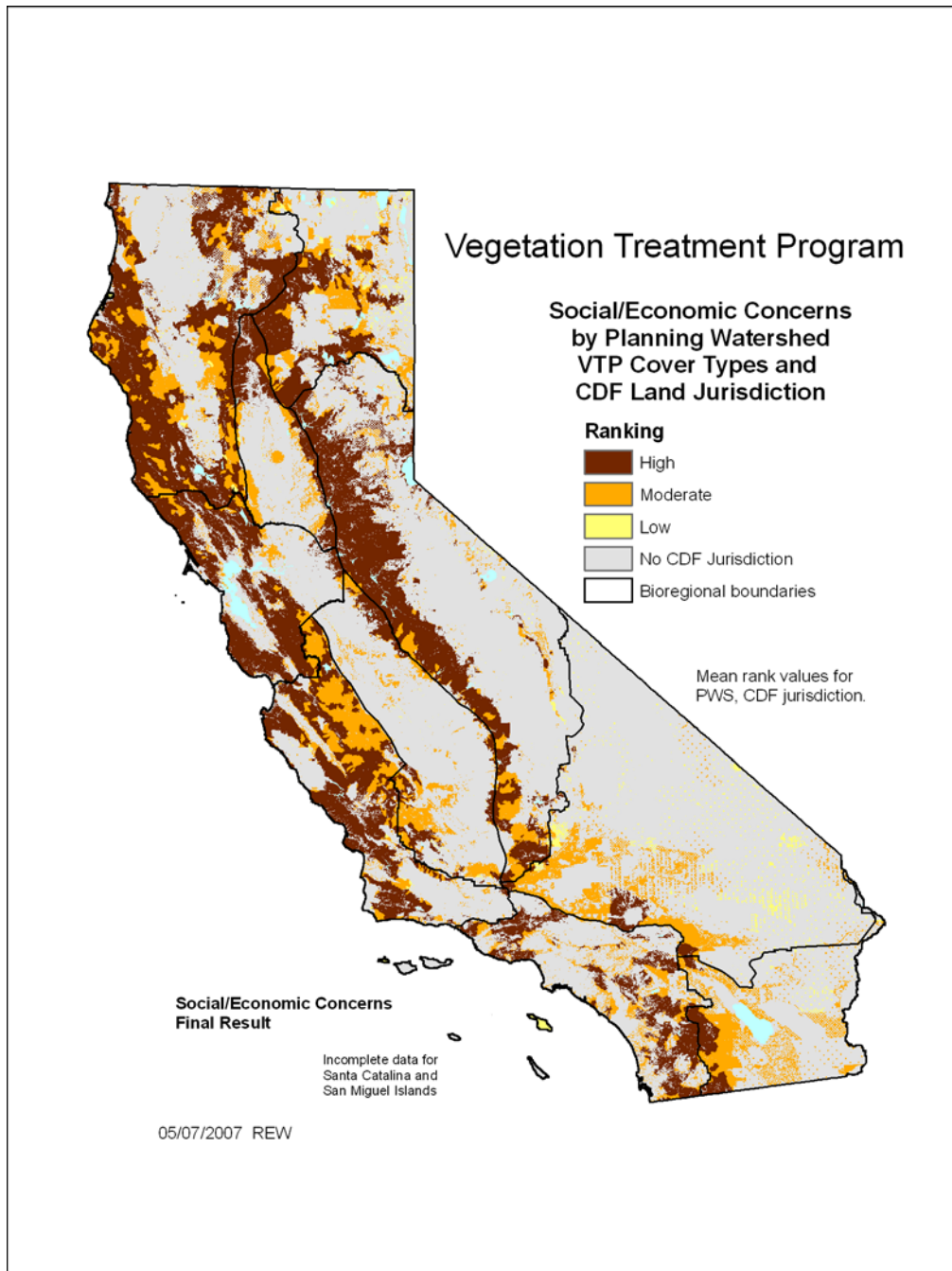
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Figure A.7 Evaluation of Social/Economic Concerns, which combines Infrastructure Values (Figure A.9a) and Natural Resource Commodities Values (Figure A.7b). This is the first of two inputs to the Values at Risk map.

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Vegetation Treatment Program

Natural/Cultural Resource Concerns
by Planning Watershed
VTP Cover Types and
CDF Land Jurisdiction

- High
- Moderate
- Low
- Non CDF Jurisdiction

Mean rank values for
PWS, CDF jurisdiction.

Natural/Cultural Resource Concerns
(same as Environmental Services Values)
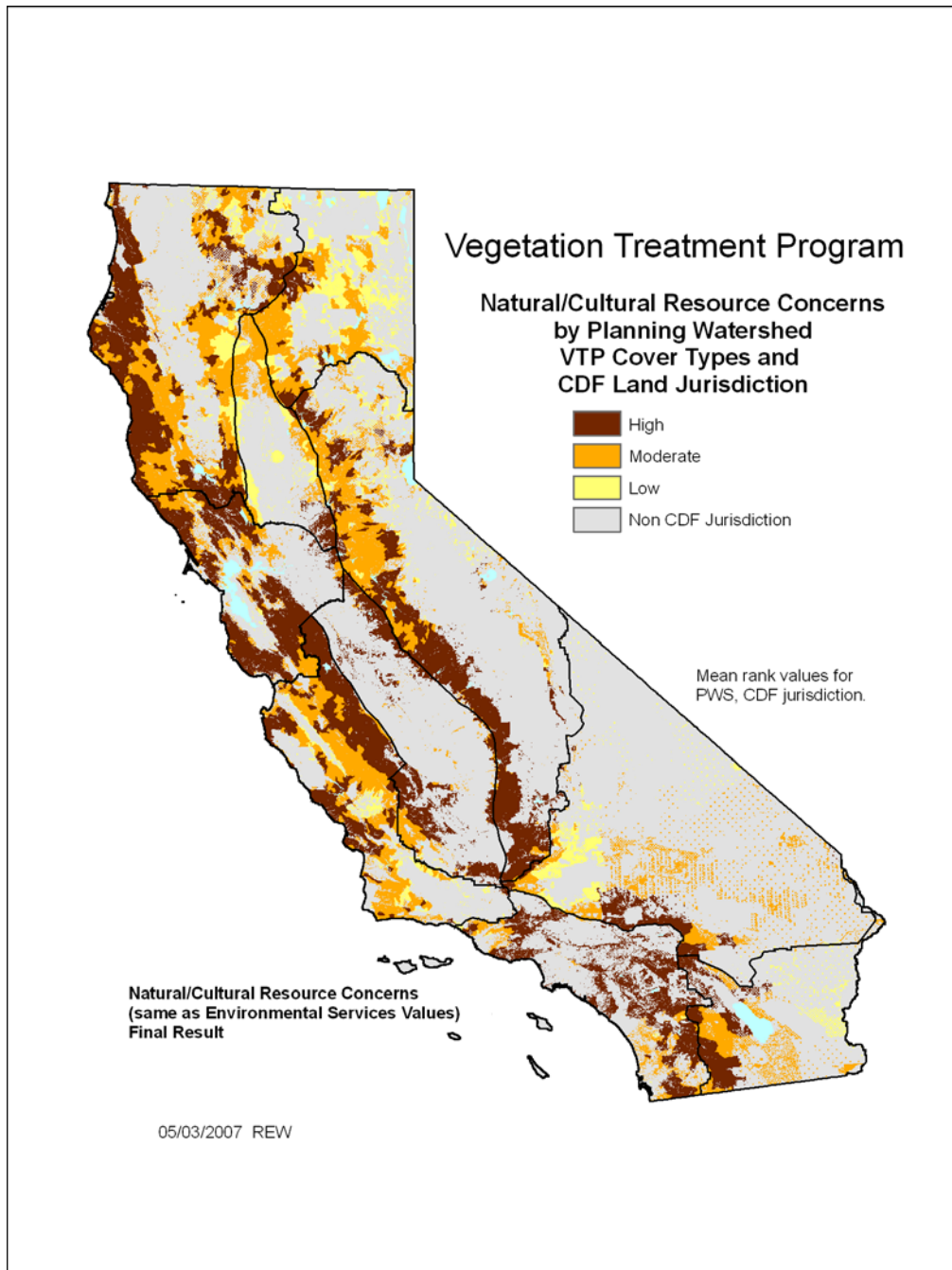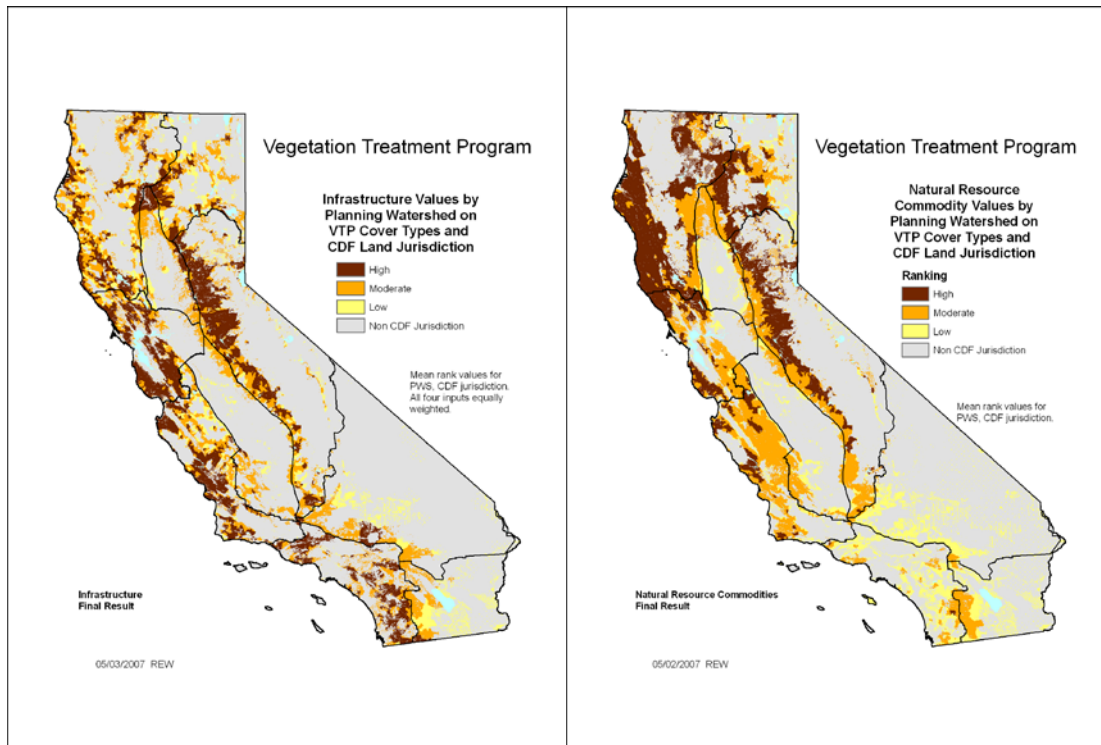Final Result

05/03/2007 REW

Figure A.8 The final result for Natural and Cultural Resource Concerns. Archaeological data were unavailable for this study, thus the result is identical to the Environmental Services evaluation (Figure A.10). This is the second of two inputs to the Values at Risk map.

Figures A.9a and A.9b Maps of final results of Infrastructure Values and Natural Resource Commodity Values on VTP jurisdiction lands, which combined to created Social/Economic Concerns (Figure A.5). Infrastructure Values had five data inputs and Natural Resource Commodity Values used four data inputs.
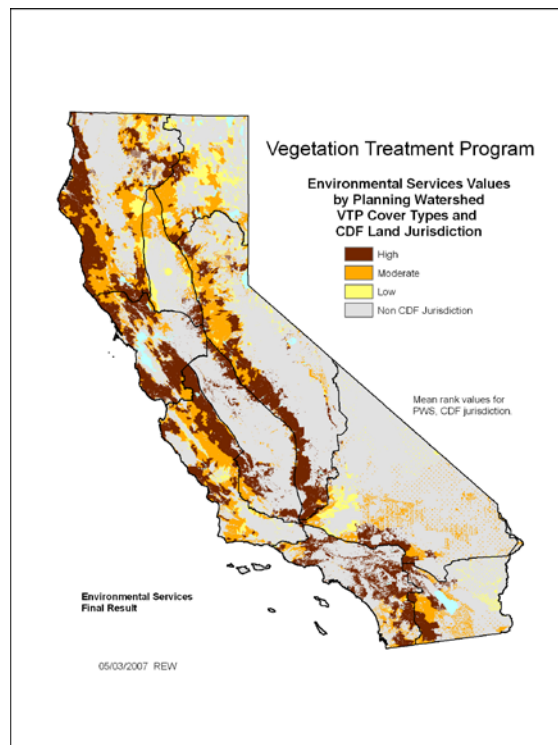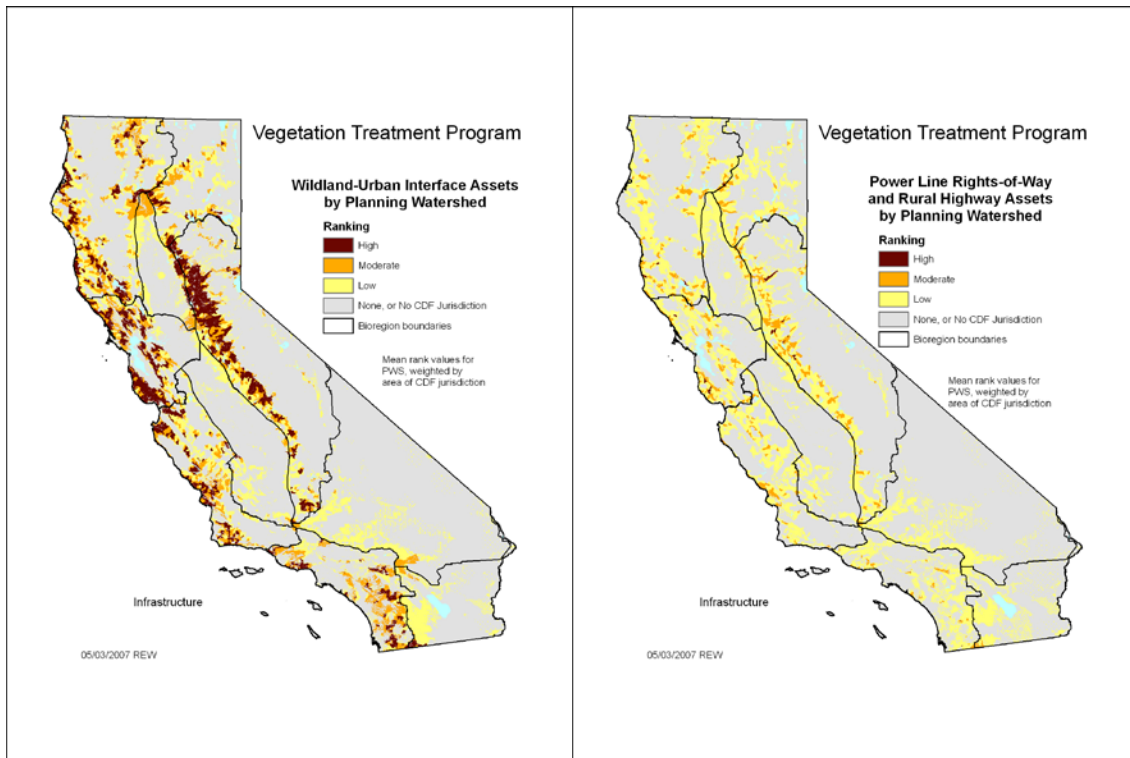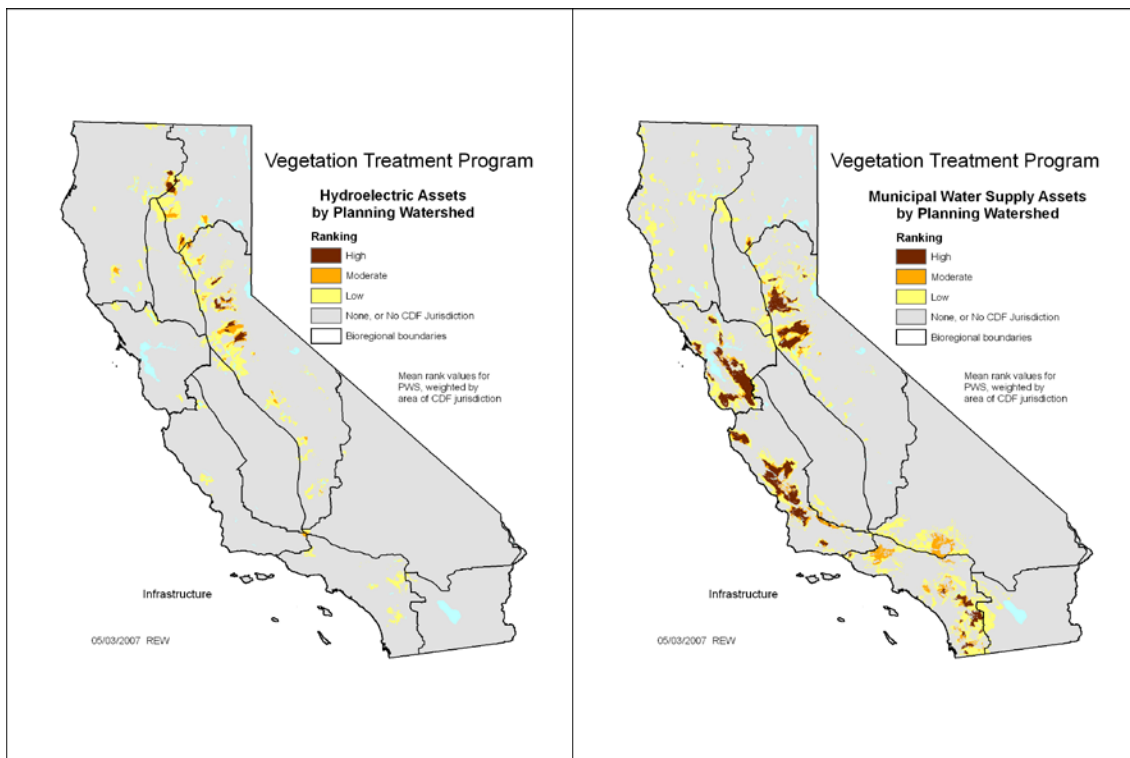

Figure A.10 Map of the final results of Environmental Services Values, the sole input to Natural/Cultural Resource Concerns. Five data sources contributed to this map.

Figures A.11a and A.11b The first two (of four) inputs to the evaluation of Infrastructure Values (Figure A.9a): Wildland-Urban Interface Assets, and (combined) Power Lines and Rural Highways Assets
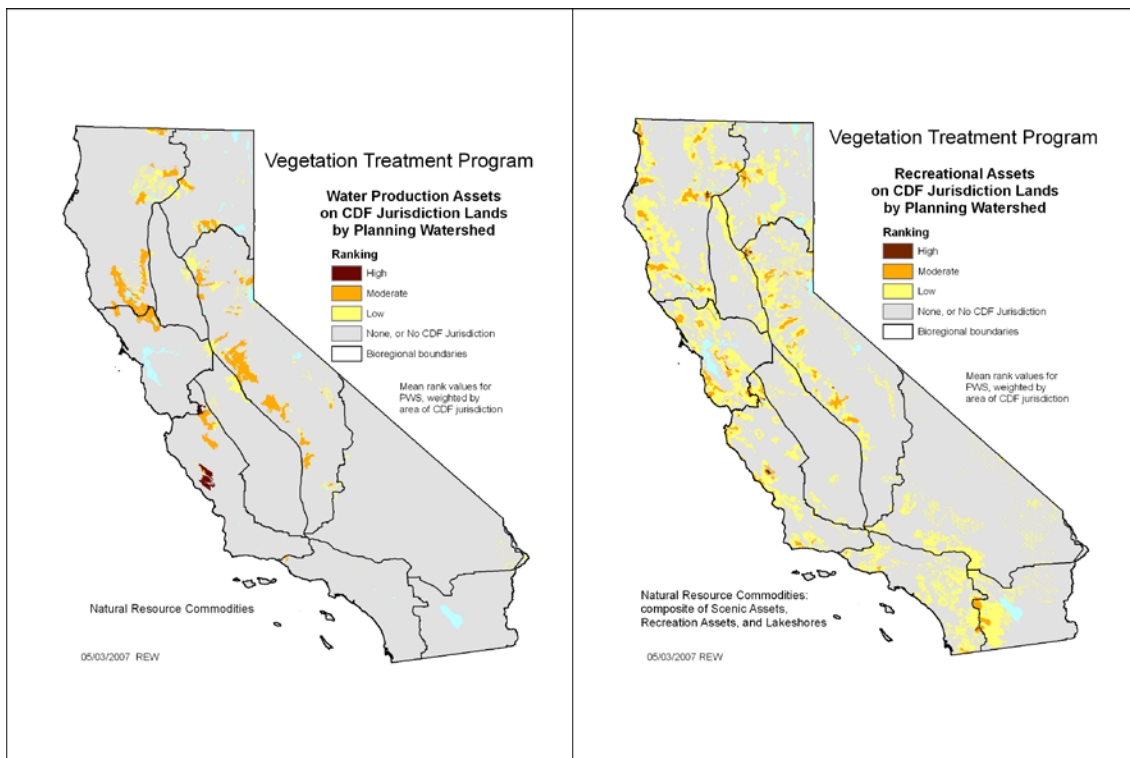

Figures A.11c and A.11d Inputs 3 and 4 (of four) to the evaluation of Infrastructure Values (Figure A.9a): Presence of Hydroelectric Assets and Municipal Water Supply Assets. Combined highway and power line infrastructure rankings ranged from one (low importance) to 3 (high importance) by PWS.
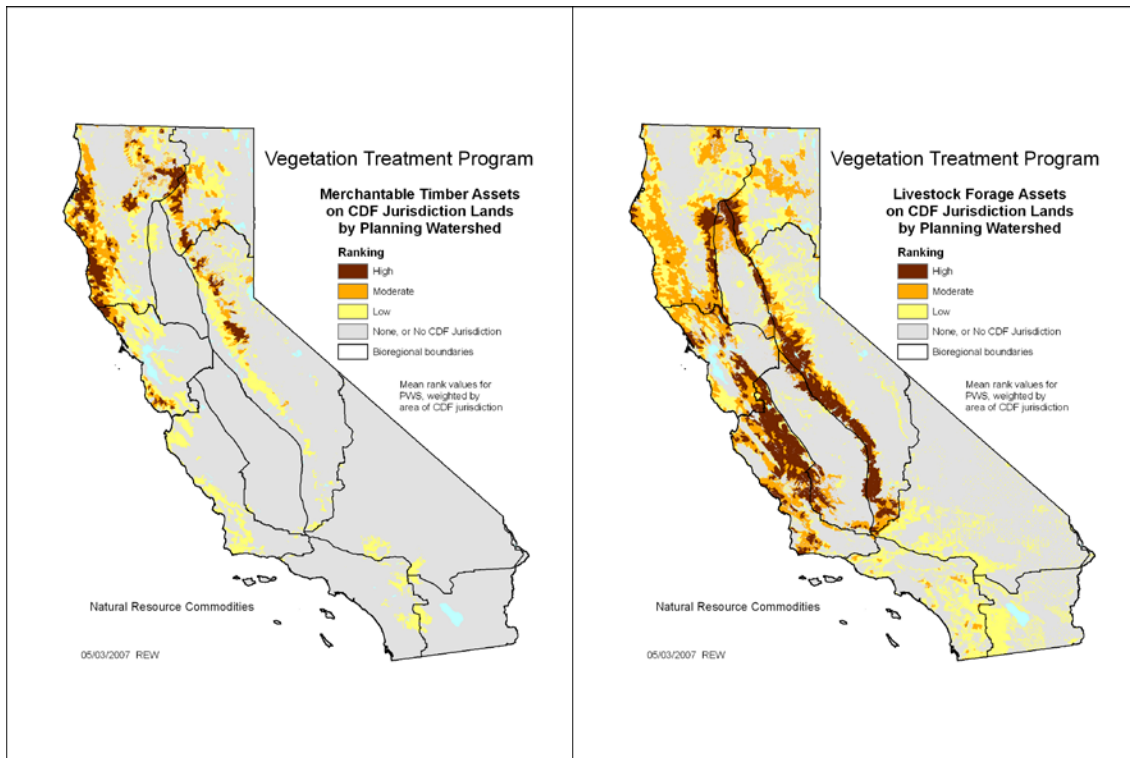
Figures A.12a and A.12b First and second of the four inputs to the Natural Resource Commodity evaluation: Merchantable Timber Assets and Livestock Forage Assets, weighted 43% and 7% respectively of the composite result.

Figures A.12c and A.12d Maps of the data inputs 3 and 4 (of four) to Natural Resource Commodity evaluation: Water Production Assets and Recreational Assets, weighted 36% and 14% of the final result.

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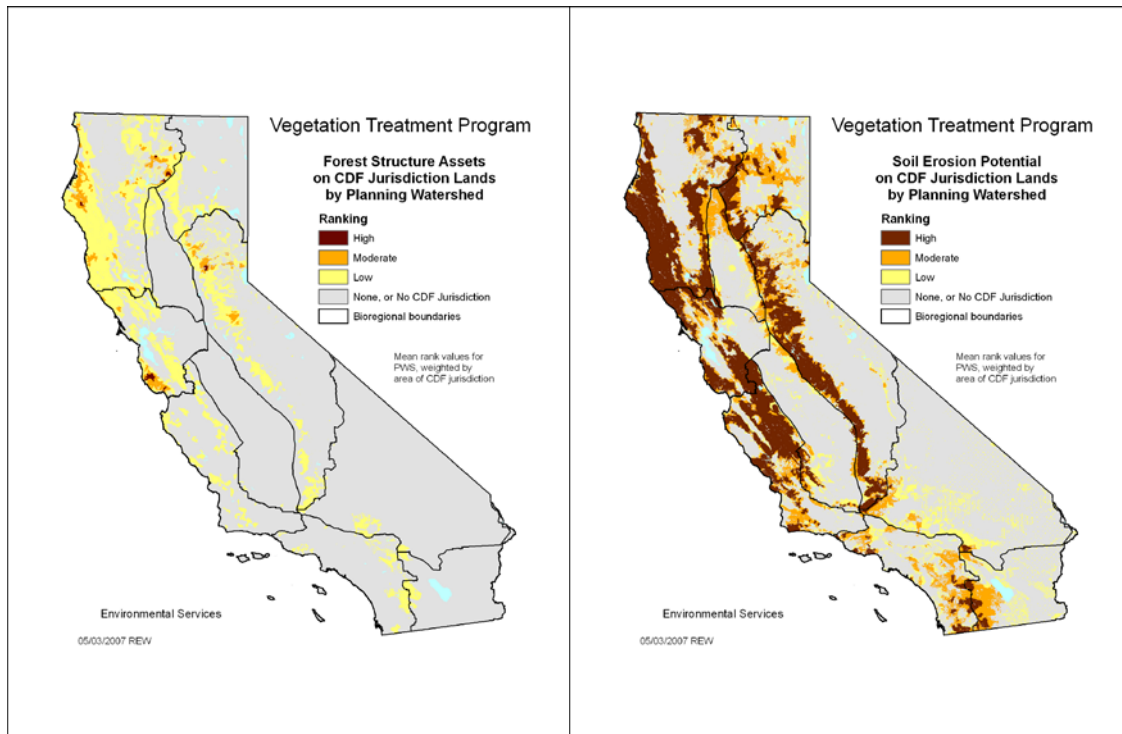
Figures A.13a and A.13b Data inputs 1 and 2 (of five) to the Environmental Services evaluation (Figure A.10): Forest Structure Assets (large trees) and Soil Erosion Potential.
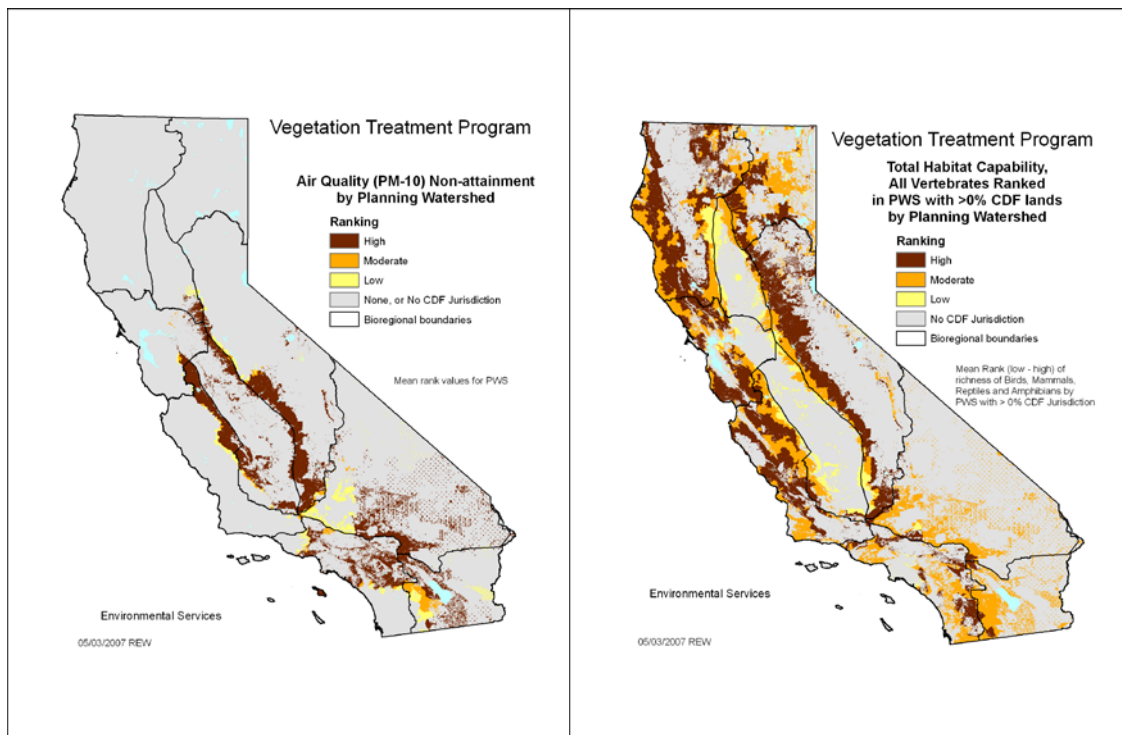
Figures A.13c and A.13d Data inputs 3 and 4 (of five total) to the Environmental Services evaluation, Ranked Air Quality PM-10 Non-attainment PWS, and Ranked Total Habitat Capability for vertebrates.

Figure A.13e The 5th of 5 inputs to the Environmental Services evaluation, showing the Number of Species Listed in the California Natural Diversity Database (CNDDB).

Discussion

We used the best available spatial information to create maps highlighting and ranking areas according to the potential benefit they would receive from the program. The main tasks were: defining the logic by which to evaluate the areas for p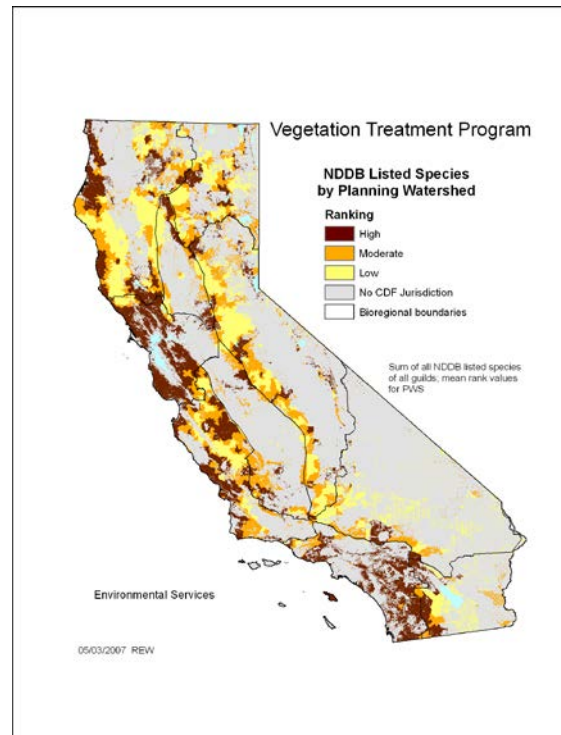rogram need; finding spatial data appropriate for the model inputs, normalizing the results among the various data sources, both spatially and thematically; and deciding on thresholds between low, medium and high rankings in the intermediary and final mapped outputs.

Results of Relative Risk Ratings by major VTP area of jurisdiction, by Bioregion

Klamath / North Coast Bioregion Risk Ratings

Coastal Mountains and Valleys

Low-lying areas adjacent to the coast, such as the Eureka Plain and along the coast from Point Arena to Fort Bragg, were the only places with a low Relative Risk ranking in this subregion. High and moderate risk areas occurred in a varied patchwork across the remaining watershed with CAL FIRE jurisdiction. The main determinant separating the two higher ratings appeared to be the relative concentration of infrastructure values.

Interior Foothills and Valleys

Grass-dominated valley watersheds in Siskiyou County and the west side of the Sacramento Valley were rated as low in risk. High risk areas were concentrated around the oak-dominated vegetation in the northwestern Sacramento Valley, conifer and

mixed hardwood conifer areas around the Scott Valley and on the northern side of the Shasta Valley (Siskiyou County), and southwestern Siskiyou County in the forested open valleys of the Cascade Range. Areas of moderate risk included wildland chaparral and mixed forests on the west side of the Sacramento Valley, most of the checkerboard private holdings (legacy of the railroads) and central Siskiyou County.

Modoc Bioregion Risk Ratings

Low to mid elevations of the west slope of the Cascade Range

High risk dominate this southwestern subregion of the Modoc bioregion, mainly in conifer forest and shrub vegetation types. Wildland-Urban Interface areas are common. Growing retirement communities like Burney and the Paradise/Magalia area, in concert with high wildland fuel loadings, likely contributed to the high ratings. In addition, several large fires have burned in this region in recent years, and this high rate of ignition also likely contributed to the high risk ratings.

Valleys of the Cascade Range and the Modoc Plateau

Few watersheds in this subregion came out as high risk in this analysis, likely due to the mostly dispersed fuel loadings and sparse infrastructure values. One exception is the area around Susanville, with its above average concentration of infrastructure values.

Sacramento Valley Bioregion Risk Ratings

Northern end of Valley

This subregion is dominated by high risk watersheds. These are areas in Shasta County and northern Tehama County with a high percentage of WUI, in oak woodland dominated vegetation (rural developments around Redding and northwest of Red Bluff).

Fringe of the Valley (east and west sides)

High risk also shows up in the small sliver of the bioregion on the gradient to the Sierra Nevada foothills in the vicinity of Oroville and southwards. On the other extreme, only low risk occurs in grass-dominated watersheds on the fringe of the foothills on both sides of the valley from central Tehama County southwards.

Sierra Nevada Bioregion Risk Ratings

Westside foothills and middle elevations and Truckee area

This subregion is almost uniformly of high risk, due to the concentration of WUI and other assets contributing to infrastructure values, in combination with chronically high wildland fuel loadings. The Interstate-80 corridor near Truckee also show as being high risk. About the only exceptions are found in moderate risk areas in the lowest elevation areas (oak woodland gradient to oak savanna and grasslands) particularly in southern Tulare and northern Kern counties.

Arid mountains at southern tip of Sierra Nevada

All three risk categories appear in nearly equal proportions in the area southeast of Bakersfield towards Tehachapi, largely dependent on the vegetation type dominant. Grassland dominated watersheds are typically lower risk, while shrub and hardwood forest dominated watersheds are rated higher.

Bay Area / Delta Bioregion Risk Ratings

Marin Peninsula and San Pablo Bay north

Risk levels appear strongly bimodal in this subregion, with most of the area being in either low or high risk categories. Lowest average elevation watersheds, most often grass dominated, came out as low risk, even though there is much dispersed development in these areas. The high risk watersheds tended to have forest resources near the coast, or forest and chaparral in mountainous areas inland.

East Bay and parts Southeast

Several of these watersheds are dominated by heavy development and are at low risk of wildland-related fire. High risk areas occurred on the southwest side of the Diablo Range in hardwood woodland and chaparral vegetation.

Coast Ranges west of Santa Clara Valley

Most watersheds in the core of the Santa Cruz Mountains came out as high risk, some but areas adjacent to the coast were low risk, likely due to marine influence and few historical ignitions. Leeward of the mountains came out low as well, where vegetation transitions to hardwoods, also with low likelihood of ignition.

San Joaquin Valley Bioregion Risk Ratings

Fringe of Sierra Nevada foothills and southwest of subregion

The scant areas of CAL FIRE jurisdiction are mostly of low risk due to domination of grasslands. The few areas of high risk have chaparral and hardwoods dominant.

Central Coast Bioregion Risk Ratings

Interior hills and mountains east-southeast of Salinas River Valley

A mosaic of different risk levels resulted in the study for this subregion, with moderate risk watersheds in the majority. Fire hazard is fairly high for these hardwood woodland and chaparral dominated watersheds, but the concentration of infrastructure assets is relatively low.

Coast ranges west of Salinas River Valley, and areas west of Transverse Ranges

CAL FIRE jurisdiction lands in these watersheds are similar in hazard to others in the bioregion, but have a higher concentration of infrastructure values. Thus the ratings are generally of high risk for these watersheds.

Mojave Bioregion Risk Ratings

Very little of this bioregion is of high risk, the exception being the south-central area on the I-15 corridor in the vicinity of Victorville, due to the combination of WUI and higher fuel loadings (higher elevation desert).

South Coast Bioregion Risk Ratings

Wildland area of Ventura and western Los Angeles counties

A large proportion of the land available to the VTP in this subregion (and in the South Coast bioregion overall) has a high risk ranking. Exceptions are the moderate-ranked fringes of the San Fernando Valley and the rugged area between Thousand Oaks and the Oxnard Plain.

Wildland-dominated foothills and mountains

Much of the interior rugged chaparral dominated wildland of this subregion is ranked high risk. Low risk areas tended to be located in lower areas of flat terrain, often close to the coast.

Colorado Desert Bioregion Risk Ratings

Greater Anza Borrego State Park and desert area to the east

The lower and drier (more eastern) sections of the state park came out as low risk, as did the few wildland areas of the Imperial Valley and nearly all of the desert to the east.

Mountainous areas to the west of Anza Borrego State Park

Higher elevation areas often with chaparral cover ranked moderate to high in relative risk.

Table A.2 Summary of Relative Risk Ratings by major VTP area of jurisdiction (summary of Figure A.1, using subregions defined in Table A.1)	
Bioregion	Overall Subarea Rating
Klamath / North Coast	1) Mostly High and Moderate, low-lying coastal areas ranked Low 2) Oak woodland and chaparral ranked High to Moderate; flatter grassland areas ranked Low
Modoc	3) High risk nearly ubiquitous 4) Moderate and Low risk dominant
Sacramento Valley	5) High risk at northern extreme, low risk in less-settled grassland areas 6) Low risk, except for gradient into Sierra Nevada foothills
Sierra Nevada	7) Vast tracts of High risk throughout middle elevations; Moderate to Low risk only in some areas at lowest elevations 8) Heterogeneous mix of High, Moderate and Low risk largely depending on vegetation type dominant
Bay Area / Delta	9) High (forest and chaparral) and Low (mostly grassland and oak savanna) risk areas about equally represented, with some Moderate 10) High risk in chaparral and more isolated wildlands, Low risk (of wildland fire) in more developed watersheds 11) Bimodal Low risk (semi-developed/marine-influenced) and High risk (central Santa Cruz Mountains) watersheds about equal area.
San Joaquin Valley	12) Mostly Low risk in grass-dominated watersheds on the valley fringe 13) A few scattered areas of High risk in areas of more rugged topography with (mostly) chaparral
Central Coast	14) Evenly divided patchwork mosaic of Low, Moderate and High risk watersheds. Sparsely settled in most areas 15) Much High risk area in Monterey and San Luis Obispo counties in watersheds with more chaparral and woodlands/forest. Low risk in some flat coastal areas, particularly western Santa Barbara county
Mojave	16) Only High risk area along I-15 corridor around Victorville, everything else Low risk
South Coast	17) Except for a few areas of Moderate risk, nearly uniformly High risk in this subregion 18) High risk prevalent, with a few grass-dominated fringe areas Moderate or Low risk.
Colorado Desert	19) Low risk dominant in areas with sparse desert vegetation 20) Moderate to High risk as elevation increases west into mountains

Most of the data used in this study were created by CAL FIRE, but no data were created specifically for this study. Spatial normalization was done by generalizing results at the planning watershed scale using Calwater 2.2a units. Thematic normalization of ratings was done by

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converting continuous variables into 3 level rankings based upon best judgment while looking at the results.

While the results of this model exercise are to some degree subjective, we believe it is likely that a different exercise with a similar goal would have results similar to those we obtained. The advantage of the exercise is in its open logic, and consistency and repeatability examining data relevant to the VTP across large millions of acres of California.

VTP Treatment Constraints Model Development and Implementation

The Treatment Constraints model was developed to map areas where VTP treatment practices may be constrained due to human-related or environmental factors. The model structure and inputs underwent the same process of review as was done for the opportunities/potential model. Figure 14 shows a simplified version of inputs and how they were combined to assess constraints.

Treatment constraints were modeled according to how the treatment could potentially affect Social/Economic Values and/or Natural/Cultural Resource Values. Social/Economic Value constraints, in turn, were derived from constraints caused by the presence and concentration of Infrastructure, any Air Quality Restrictions, and Management Restrictions. Infrastructure was defined in the same way as for the Relative Risk analysis above. Air Quality restrictions were generalized from data on particulates from the Air Monitoring Board. Management restrictions were present primarily in areas managed by state parks and reserves, and the coastal zone administered by the state Coastal Commission.

Natural/Cultural Resource Value constraints came from evaluations of Natural Resource Constraints only (no data were available for the Cultural Resource Constraints input). The inputs differed from those used for Natural Resource Commodity Concerns in the analysis above. Input data for this portion of the model included the presence of sensitive species, the amount of stream management zone present in the watershed, whether the watershed was classed as Priority Category I, and the percentage of slopes of 35% or greater.

Unlike the former modeling exercise where there is one result for the entire program, in modeling constraints we had to take each of the five main treatment practices (prescribed burning, mechanical, manual, herbicide and herbivory) in combination with the five alternatives, resulting in twenty-five maps from this analysis. Several of them have low constraints on virtually all areas in the state (e.g. manual removal).

The five alternatives emphasize different objectives. The Proposed Program seeks to maximize the effects of the VTP in mitigating wildland fuel hazards, maintaining wildlife habitat and long-term watershed enhancement and maintenance. Alternate 1 is simply a continuation of the current VMP. Alternative 2 has the Proposed Program but eliminates the use of herbicide treatments. Alternative 3 focuses on minimizing potential negative impacts on water quality, and Alternative 4 puts air quality concerns above all others.

Allowances were made for differences in each bioregion's sensitivity to a given treatment. In order to characterize the sensitivity by bioregion to treatment practices among the five

alternatives, we developed a matrix of coefficients (values between 0 (treatment highly constrained) and 1 (treatment has no constraints)) to indicate the level at which we believed a given practice could impact that bioregion. Coefficients and were generalized into five categories of potential impacts on a given resource: very high (0.0); high (0.2); moderate (0.5); low (0.8); and very low (1.0), and were multiplied by the ranking in each watershed. Coefficients are used to multiply a given input value. One (1.0) keeps the value the same (i.e. "no constraints"), whereas zero (0.0) reduces it to nothing ("no go").

Table A.3 has the list of representative coefficients for the state as a whole. Two groups of bioregions emerged which had similar sensitivities by treatment practice. The first group was comprised of the less-constrained or less-sensitive rural and interior bioregions: Klamath North Coast; Modoc; Mojave and Colorado Desert. The second had the six other bioregions in the state: Sacramento Valley; Sierra Nevada; Bay Area / Delta; San Joaquin Valley; Central Coast; and South Coast, where sensitivity to management practices and restrictions tend to be higher (tables not shown).

Some of the input data and their compilations into ratings for this model were also used in the Opportunity/Potential model described in the above section (e.g. Infrastructure Constraint Rating). However, their purpose here was to highlight where certain treatment types may be restricted due to risk to assets should the treatment get out of control.

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Table A.3
Summary of Constraint Coefficients, by Alternative, Treatment Practice and Constraining Factor or Value. Most constraining = 0;
Totally unconstraining = 1; Moderately constraining = 0.5, etc. Values varied slightly between bioregions (not shown).

VTP Alternatives:	Treatment Practices:	WUI	Power Line ROW	Water Impound.	Rural Hiwy	Air Quality	Coastal Zone	Reserves and Parks	T & E Spp.	Priority Watershed	Slopes >=35%
Proposed Program	Prescribed Burning	0.2	0.5	1	0.8	0.5	0.8	0.8	0.5	0.8	1
	Manual	1	1	1	1	1	1	1	1	1	0.8
	Mechanical	1	1	1	0.8	1	0	0.5	0.5	0.8	0.5
	Herbicides	0.8	1	1	0.8	1	0.2	0.2	0.5	1	0.8
	Biological (Grazing)	1	1	1	1	1	0.8	0.8	1	0.8	1
Alternative 1: Status Quo	Prescribed Burning	0.2	0.5	1	0.8	1	0.8	0.8	0.5	1	1
	Manual	1	1	1	1	1	1	1	1	1	1
	Mechanical	1	1	1	0.8	1	0	0	0	0.8	0.5
	Herbicides	1	1	1	0.8	1	0.2	0.2	0.5	1	1
	Biological (Grazing)	1	1	1	1	1	0.8	0.8	1	0.8	1
Alternative 2: No Herbicides	Prescribed Burning	0.2	0.5	1	0.8	1	0.8	0.8	0.5	0.8	1
	Manual	1	1	1	1	1	1	1	1	1	0.8
	Mechanical	1	1	1	0.8	1	1	0.5	0.5	0.8	0.5
	Herbicides	0	0	0	0	0	0	0	0	0	0
	Biological (Grazing)	1	1	1	1	1	0.8	0.8	1	0.8	1
Alternative 3: Water Quality	Prescribed Burning	0.2	0.5	0.8	0.8	1	0.8	0.8	0.5	0.5	0.8
	Manual	1	1	0.8	1	1	1	1	1	1	0.8
	Mechanical	1	1	0.8	0.8	1	1	0.5	0.5	0.2	0.2
	Herbicides	0.8	1	0.8	0.8	1	1	0.2	0.5	1	0.8
	Biological (Grazing)	1	1	0.8	1	1	0.8	0.8	1	0.8	1
Alternative 4: Air Quality	Prescribed Burning	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Manual	1	1	1	1	1	1	1	1	1	0.8
	Mechanical	1	1	1	0.8	1	1	0.5	0.5	0.8	0.5
	Herbicides	0.8	1	1	0.8	1	1	0.2	0.5	1	0.8
	Biological (Grazing)	1	1	1	1	1	0.8	0.8	1	0.8	1

Vegetation Treatment Program GIS Potential Constraint Model
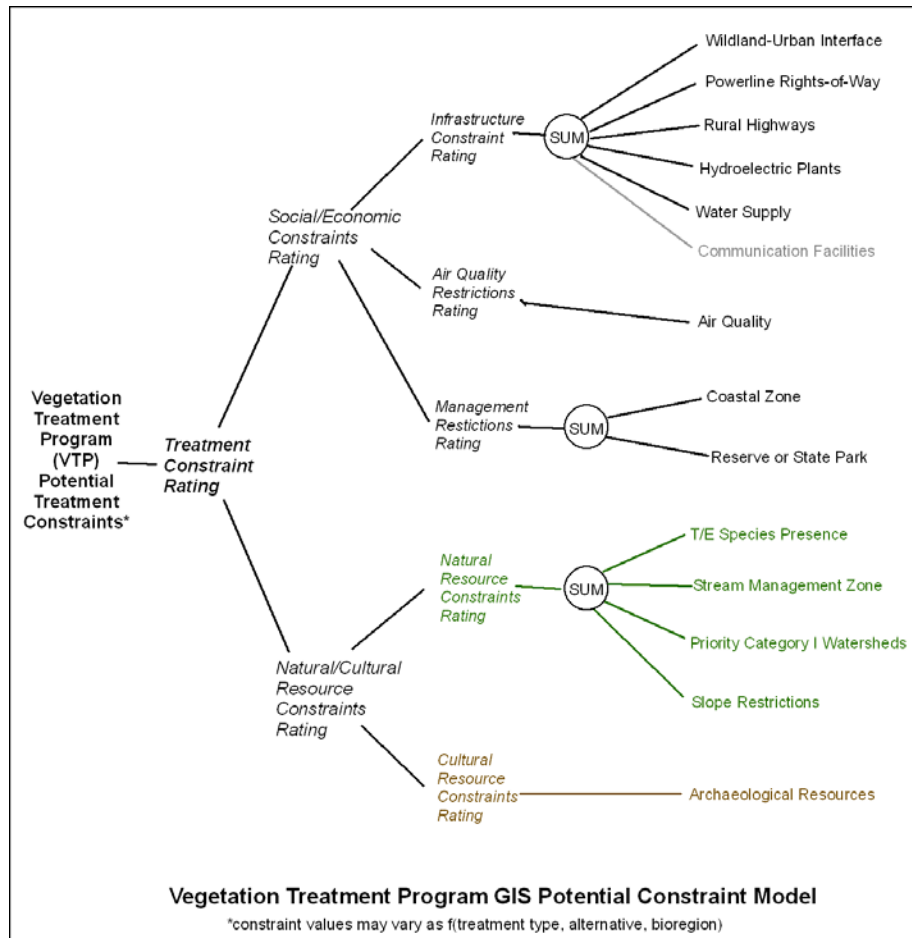*constraint values may vary as f(treatment type, alternative, bioregion)

Figure A.14 Generalized graphic of the GIS Potential Constraints Model

Summary of results

Here we summarize resultant constraints by treatment practice. For two of the five practices, Manual and Biological (Grazing) treatments, our analysis showed that they would not be constrained in any watersheds under any alternative, due to their relatively low overall impacts on all values (Figures A.18a and A.18b).

The other three practices are Prescribed burning, Mechanical and Herbicide treatments. These can potentially have a higher level of impact on the environment, and some can also pose risk to assets (e.g. prescribed burning near building structures). Through the coefficient matrix (Table A.3) the degree of constraint in each planning watershed was modeled according to three factors: 1) the presence (and concentration) of some value(s) or asset(s) in the watershed which could potentially be adversely impacted by the practice (e.g. mechanical treatment on steep slopes); 2) the alternative, since different resources are emphasized to varying degrees (e.g. Alternative 4 emphasizes clean air over other resources); and 3) bioregion, which in some cases can be more or less sensitive to the resource being affected (e.g. air quality is less of an issue in the Modoc than the San Joaquin Valley).

Appendix A

Throughout this analysis, the level of constraint (low, moderate, high) imposed on a practice (e.g. prescribed burning) was determined according to each asset potentially at risk (e.g. infrastructure) of inadvertent damage by the practice. For each planning watershed, the most constraining value or asset was taken as the level of constraint for that practice. For example, if infrastructure constrained prescribed burning more than any other asset in the model, then that value of constraint was taken as the most conservative estimate of constraint for prescribed burning in that watershed.
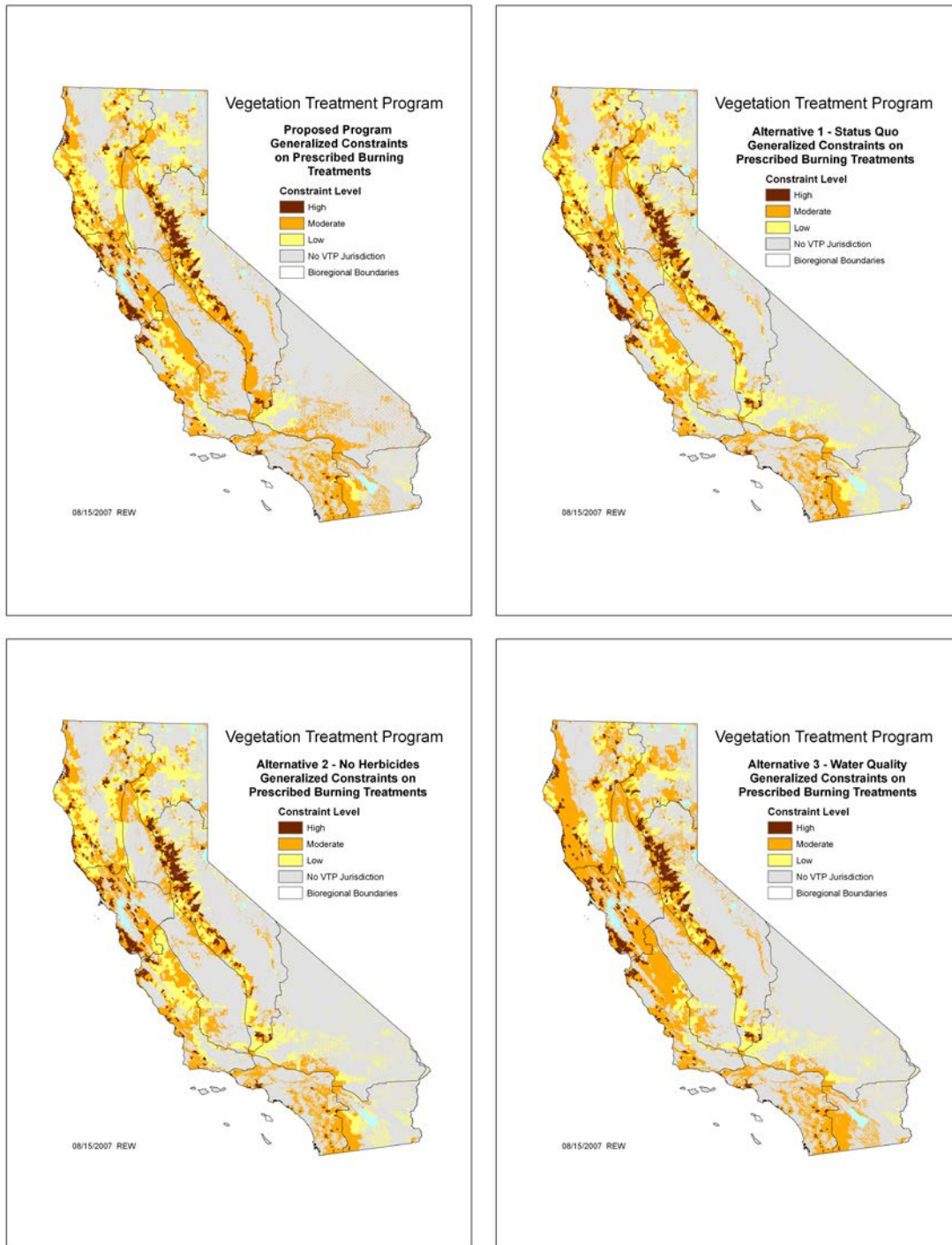
Prescribed Burning Treatments

Prescribed burning is a treatment with potential for high level impacts from smoke, and which can pose some risk to infrastructure values if it escapes control. The main factors in the model that drive the constraint rating to high are the presence of wildland-urban interface (WUI) and power lines, chronic air quality problems and the concentration of sensitive species (Figures A.15a through A.15e). Tables A.4 and A.5 summarize potential constraints on prescribed burning treatments by bioregion for the Proposed Program and Alternatives 1 through 4. The pattern of high, moderate and low constraints varies over the planning watersheds according to the proportion of factors listed above.

The results for Alternative 4, which emphasizes air quality above other assets, were significantly different for prescribed burning treatments. In the majority of planning watersheds with VTP jurisdiction across the state, prescribed burning treatments show as likely to be highly constrained, with very few areas of low constraints.

Mechanical Treatments

Mechanical treatments involve the use of heavy machinery such as tractors to remove or pile vegetation for subsequent burning. All alternatives except Alternative 3 (Water Quality) resulted in similar constraint values across the state, about equally divided between moderate and low constraints (Figure A.16a). Alternative 3 results show high constraints in many areas in the state, particularly where there is a significant proportion of the watershed in steep slopes (Figure A.16b).

Appendix A

Figures A.15a through A.15d Potential Constraints on Prescribed Burning treatments in the Proposed Program and Alternatives 1 through 3.

Appendix A
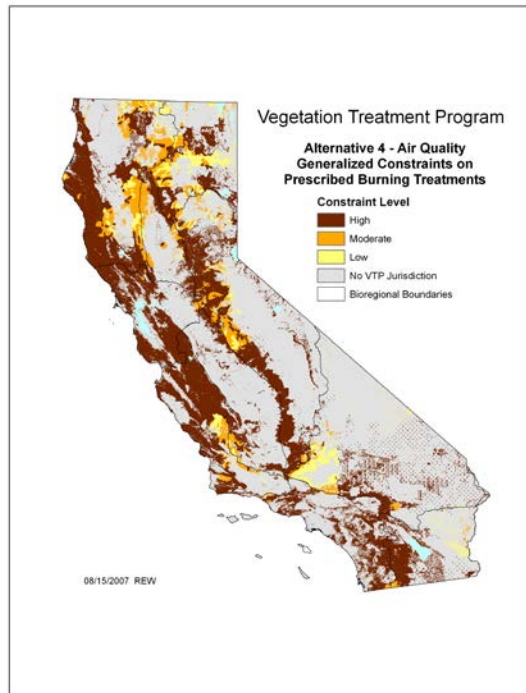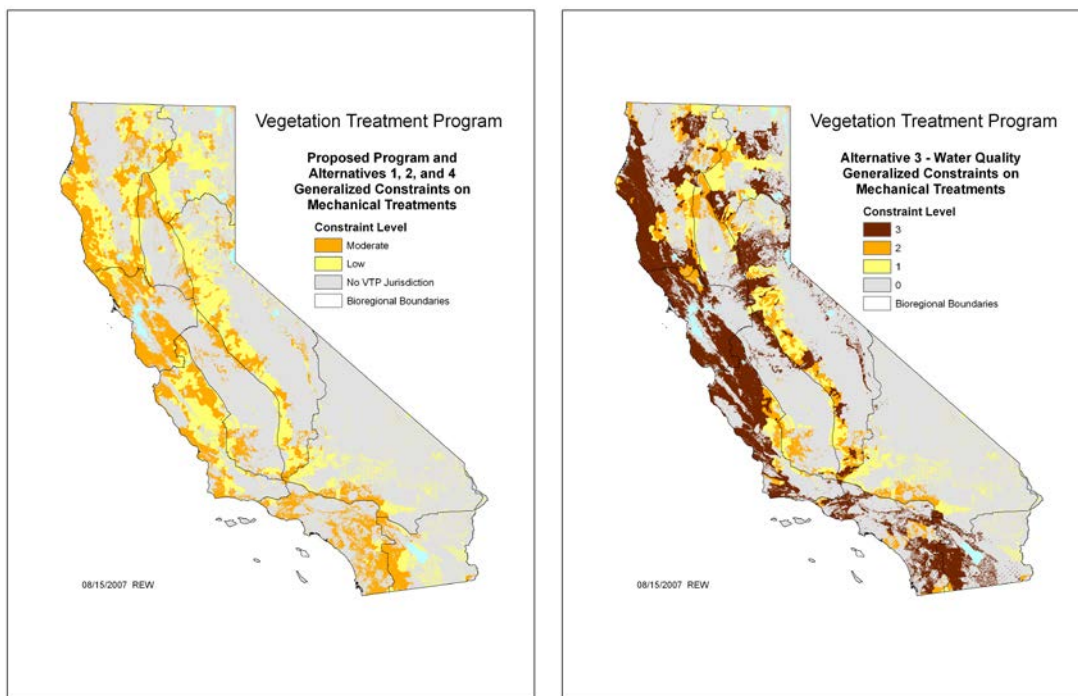

Figures A.15e Potential Constraints on Prescribed Burning treatments by Alternative 4.

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Table A.4 Summary of Constraints on Prescribed Burning Treatments for the Proposed Program and Alternatives 1, 2, and 3	
Bioregion	**Overall Subarea Rating**
North Coast / Klamath	1) Low and Moderate constraint levels dominate, the few High rankings mainly driven by WUI (Eureka Plain, Mendocino coast, Garberville/Willits, lower Clear Lake). Low constraint turned to Moderate across most of the subregion in alternative 3. 2) Low to Moderate constraint levels with very localized High, mainly around the larger communities in the region (and surrounding WUI).
Modoc	3) Nearly all Low and Moderate constraint levels, excepting very localized High levels near communities of Magalia/Paradise, Shingletown, Burney, parts of Lake Almanor 4) Mainly Low constraints throughout, few areas of Moderate and localized High near Susanville and Bieber.
Sacramento Valley	5) About half eligible area in subregion rated Low and half Moderate constraint levels. 6) Low and Moderate constraints throughout, only High constraint levels in and around communities in the lower foothills of the Sierra Nevada.
Sierra Nevada	7) High level of constraint dominates northern Sierra foothills and middle elevations around communities. Southern portion mostly Moderate constraint levels in Proposed Program, about even mix of Low and Moderate with localized High around communities in the three alternatives. 8) Repeat of pattern from northern Sierra Nevada subregion, High constraint area around Tehachapi.
Bay Area / Delta	9) Heterogeneous mix of constraint levels dominated by Moderate, but with Low in northwestern Sonoma County and western Yolo County and significant patches of High in areas with considerable WUI. 10) Moderate constraint level dominates, areas of significant WUI are High, and very rural isolated areas to the south are Low. 11) High constraint levels dominate (central Santa Cruz Mountains), with the remainder in Moderate constraint levels.
San Joaquin Valley	12) Moderate constraint levels ubiquitous – low risk to assets except air quality 13) All Moderate constraint levels except areas of Low constraints in west / southwest.
Central Coast	14) About half of the subregion is Low constraint, half Moderate constraint, with alternative 3 showing mostly Moderate. 15) Mostly Moderate constraint level, punctuated by High level of constraints around Monterey/Salinas and communities southwards.
Mojave	16) Low constraint level dominates. Moderate constraint levels around communities to south of region (Lancaster/Palmdale, Victorville), and in eastern desert areas in the Proposed Program.
South Coast	17) Moderate constraint levels everywhere except local areas around Malibu and Agoura where constraints are High. 18) As with 17) above, with High areas in rural communities with surrounding WUI.
Colorado Desert	19) Low to Moderate constraints. 20) Moderate constraints dominate towards west into mountains

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Table A.5	
Summary of Constraints on Prescribed Burning Treatments for Alternative 4	
Prescribed Burning Constraint Levels	**Bioregions**
High constraint covers nearly 100% of region	North Coast; Bay Area / Delta; South Coast; western Colorado Desert;
High constraint covers about 80% of region	Sierra Nevada; San Joaquin Valley; Central Coast; eastern Mojave
High constraint covers about 50% of region	Klamath; Modoc; Sacramento Valley; western Mojave;
Low constraint covers significant area of region	Modoc; western Mojave; Eastern Colorado Desert;

Figures A.16a and A.16b Potential Constraints on Mechanical treatments in the Proposed Program and in Alternatives 1 through 4. Alternative 3 which emphasizes water quality values, showed higher constraints on heavy machinery mainly from steep slopes.
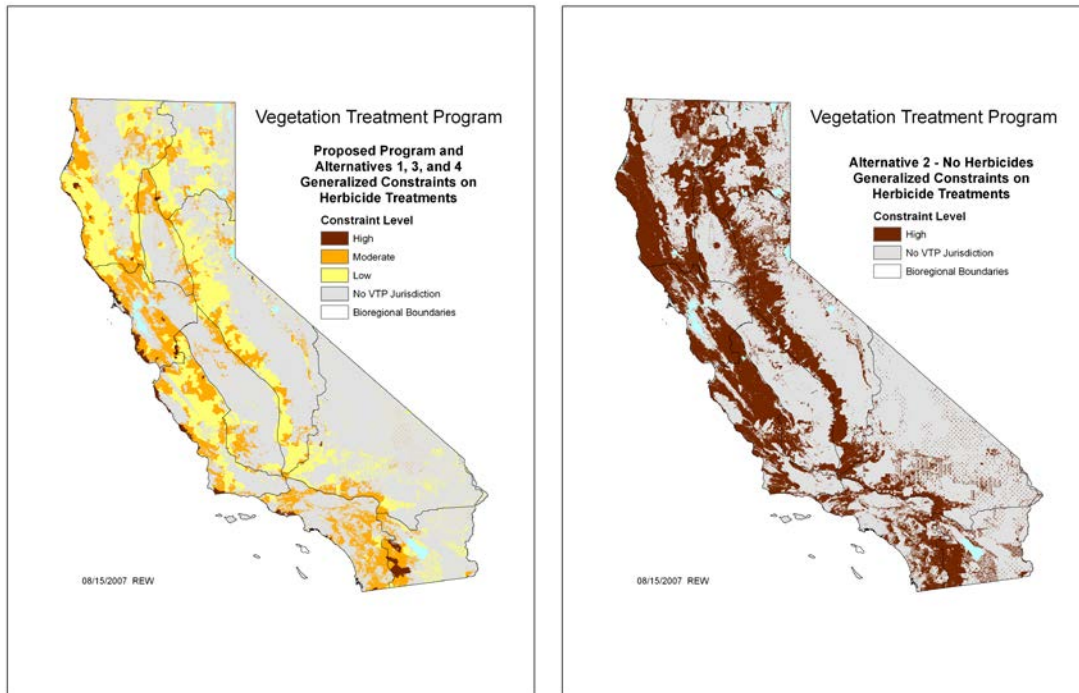
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Table A.6

Summary of Constraints on Mechanical Treatments for Proposed Program and Alternatives 1, 2 and 4

Mechanical Treatment Constraint Levels	Bioregions
Moderate constraints covers nearly 100% of region	Bay Area / Delta; South Coast
Moderate constraint covers about 70% to 80% of region; remainder is Low constraint	Western Colorado Desert; San Joaquin Valley
Moderate constraint covers about 50% of region; remainder is Low constraint	North Coast; Klamath; Sacramento Valley; Mojave; Central Coast
Low constraint dominates region	Sierra Nevada; Modoc; eastern Colorado Desert;

Table A.7

Summary of Constraints on Mechanical Treatments for Alternative 3

Mechanical Treatment Constraint Levels	Bioregions
High constraint covers nearly 100% of region	North Coast; Bay Area / Delta; South Coast; western Colorado Desert;
High constraint covers about 80% of region	Central Coast;
High constraint covers about 50% of region	Klamath; Modoc; Sacramento Valley; Sierra Nevada;
Moderate and Low constraints cover most of region	San Joaquin Valley; Mojave; eastern Colorado Desert;

Herbicide Treatments

Herbicides are heavily constrained in all planning watersheds in Alternative 2 (No Herbicides) as shown in Figure A.17b. The use of herbicides in the Proposed Program and other Alternatives (1, 3 and 4) is constrained to varying degrees as shown in Figure A.17a. Table A.8 summarizes the overall patterns by subbioregion.

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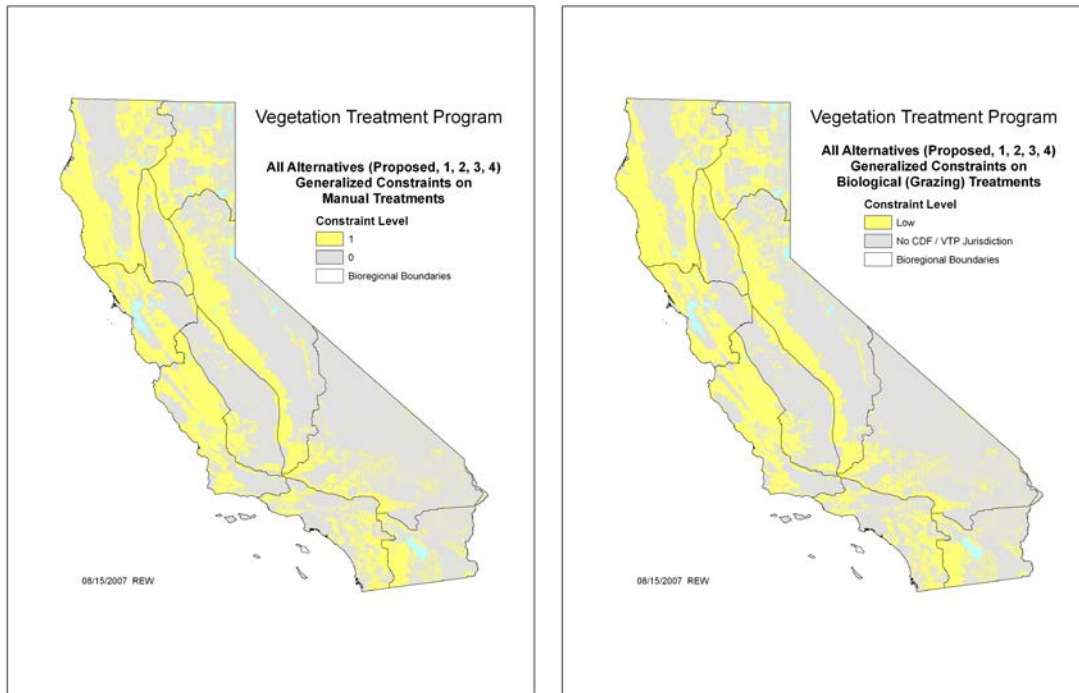
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Figures A.17a and A.17b Potential Constraints on Herbicide treatments by the Proposed Program and Alternatives 1, 3, and 4, as well as Alternative 2.

Table A.8	
Summary of Constraints on Herbicide Treatments for Proposed Program and Alternatives 1, 3 and 4	
Herbicide Treatment Constraint Levels	**Bioregions**
Moderate or High constraints cover nearly 100% of region	Bay Area / Delta; South Coast; western Colorado Desert;
Moderate constraint covers about 70% to 80% of region; remainder is Low constraint	Sacramento Valley
Moderate constraint covers about 50% of region; remainder is Low constraint	San Joaquin Valley; Central Coast
Low constraint dominates region	Klamath; Modoc; Sierra Nevada; Mojave; eastern Colorado Desert;

Manual and Biological (Grazing) treatments

The constraints modeled for these two treatment practices came out low in virtually all planning watersheds in California for the Proposed Program and all Alternatives (Figures A.18a and A.18b). According to the model, both have low impacts on known values at risk in these watersheds.

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Figures A.18a and A.18b Potential Constraints on Manual and Biological (Grazing) treatments. The maps portray the results from the Proposed Program and all alternatives – low constraints on these treatment practices across all watersheds in all bioregions of the state.

Discussion

This effort was undertaken to use current data and methods within a geographic information system to understand the levels of and geographic variations in potential constraints on the five major treatment practices used in the VTP. Sensitivity of a set of representative values in the landscape (e.g. infrastructure, air quality, water quality, sensitive species) to each treatment was determined by members of the VTP PEIR team. The level of potential constraints was then modeled for each planning watershed according to the amount of each value present and its vulnerability to adverse impacts from the given treatment. This was done for each alternative in the PEIR including the Proposed Program. The vulnerability of a given value varied in some cases according to the emphasis of each alternative – thus the differences in results between alternatives.

The intent in this analysis is to provide decision makers in the PEIR with a map-based look at the differences (if any) in potential effects of each of the alternatives on the suite of VTP treatment practices. This could help in making an informed decision based upon an analysis of the data, and in the process reach a well-balanced decision in selecting the most beneficial alternative.